PHYSIOLOGICAL ASPECTS REGARDING THE SWEET CHERRY WATER REGIME IN THE CLIMATIC CONDITIONS OF 2023

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Abstract

The lack of water in the fruit trees ecosystem can cause atmospheric and pedological drought, under the action of which the plants suffer from cell dehydration through various biochemical and physiological changes. The purpose of this study is to evaluate the water regime by assessing the state of hydration of some sweet cherry cultivars ('Van', 'Andreiaș'and 'Margonia') cultivated at Research Station for Fruit Growing (RSFG) Iași (N-E Romania) in the climatic conditions of the year 2023. The physiological indices analyzed were the determination of the water potential and the evaluation of the rate of dehydration at leaf level in three different phenological stages according to the BBCH scales: 65 (full flowering); 78 (fruits approximately 80% of final size) and 89 (fruit ripening) in two different areas of the crown: internal and external. Regarding the rate of dehydration, the results recorded statistical differences between cultivars but also at the level of crown areas within the same phenophase. The results oscillated between the minimum value of 45.62 at the 'Andreiaș' in the flowering phenophase in the internal area of the crown and the maximum of 72.28 in the outside of the crown at 'Margonia'. The water content of the leaves recorded maximum average values in the flowering phenophase of 69.90%. The climatic conditions in the growing season (March-August) were characterized by an average temperature of 17°C, with an increase of 1.9°C compared to the multiannual average and a rainfall deficit of 88 mm. The physiological response of fruit trees to drought conditions caused by high temperatures associated with a lack of precipitation was to increase the content of reserve substances and total dry matter.

Key words: *Prunus avium* L., water content, leaves, drought stress

Being widely distributed throughout the world, species of the *Prunus* genus show a variety of physiological strategies when faced with the impact of current climate change that includes water scarcity, making it possible to identify and select genotypes with high tolerance to water limitation (Jimenez *et al,* 2013; Opazo *et al,* 2020; Gonçalves *et al,* 2021).

Compared with other tree fruits or grapes, there has been relatively little research on the need to optimize water potential of sweet cherry.

Although, as irrigation water supply has become increasingly uncertain, increased interest has developed in the need to cover water shortages to improve yield, fruit quality, and control the development of phenological stages (Quero-Garcia *et al,* 2007).

Sweet cherry (*Prunus avium* L.) has become one of the most valued and economically prolific fruit crops around the world (Gonçalves *et al,* 2021) which is mainly grown in arid and semi-arid areas, with about 550 mm of annual precipitation, but in the last decade, these areas have experienced a dramatic reduction in the water regime, which has led to some adaptation changes for sweet cherry trees (Toro *et al,*2023).

Regarding the phenological stage, an adequate amount of water has a great importance in the phases of flowering and fruit development, as well as in the post-harvest period (Predieri *et al,* 2003).

Atmospheric and pedological drought causes the disruption of some physiological and biochemical processes that can have important repercussions on the ultrastructure and metabolic processes in cells (Jităreanu *et al,* 2009). The negative effects of water stress are highlighted at the foliar level primarily by decreasing stomatal opening, transpiration and photosynthesis, respectively decreasing CO_2 supply (Burzo *et al,* 1999). For the sweet cherry, water regime influences numerous parameters such as vegetative growth, fruit quality and production yield, water and gas exchange status (Predieri *et al,*2003; Vosnjack *et al,*2021).

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The aim of this study was to evaluate the water regime at the foliar level of some sweet cherry cultivars during the phenological stages in the climatic conditions of the year 2023 in the North-East area of Romania.

MATERIAL AND METHOD

Experimental site

The study was carried out during the year 2023 in the experimental field of the Research Station for Fruit Growing (RSFG) Iași, North-Eastern Romania (47°20´N; 27°60´E at 165 m altitude).

Plant material and growth conditions

The biological material used was represented by three cultivars of sweet cherry ('Van', 'Andreiaș' and 'Margonia') grown on rootstocks of medium vigor of *Prunus mahaleb* L., with planting distances of 5×4 m from, trained as a free palm tree, without an irrigation system.

The meteorological conditions in the experimental field in the last three years are characterized by an average annual temperature of 11.3℃, and total precipitation of 475 mm with a deviation of 43 mm from the multiannual values.

The soil is of meso-relief type with a gently sloping plateau and predominantly cambic chernozem soil with good natural drainage (Iurea *et al,* 2022), 3.7-4.3% humus content; pH 6.6-8.1; and 0.150-0.220% N.

Experimental determinations

Analysis of physiological parameters was performed at three different phenological stages, according to the BBCH scale (Meier, 2001) at 65 (full flowering), 78 (fruits has 80% of final size) and 89 (fruit ripening), in different areas of the crown: internal and external.

The rate of foliar dehydration was monitored by repeated weighing at intervals of 1, 2, 3, 4 and 24 hours, determining the percentage of water lost in the first hour and up to 24 hours (Jităreanu and Marta, 2020). Foliar dehydration was calculated using the formula:

DR (%) = $(x_{1-n}/x_0)\times100$, where DR - foliar dehydration (%); x_0 - the first weighing (g);

x_{1-n} - leaf weight after 1 to 24h periods of time (g).

Analysis of total water content (RW) of sweet cherry leaves was performed by laboratory oven drying method (Zhang *et al,*2012) at 104°C for 2–72 h at 80°C. Leaf water content was calculated with the equation:

RW (%) = (Fw-Dw)/ Fw × 100, where Fw- fresh leaves weight (g); Dw - weighed dry matter leaves resulted (g).

Meteorological conditions in the experimental field during the research period were monitored by an Agroexpert system.

Statistical Analysis

The data were statistically processed by the Duncan's multiple range test performed for mean separation at p ≤ 0.05.

RESULTS AND DISCUSSIONS

The analysis of climatic conditions data from the vegetation period (March-August) showed that in the experimental field at RSFG Iasi, the average monthly temperatures were higher than the multiannual average, with an deviation of +1.88 varying between -0.6°C (April) and +4.95°C (August), associated with a precipitation deficit of -87.7 mm. The relative air humidity during the analyzed period had an average value of 55.5% (*table 1*).

The absence of rain and the high day and night temperatures led to the pedological, atmospheric and physiological drought, thus shortening the phenophases (Jităreanu *et al*, 2009).

The amount of precipitation recorded during the time period that was analyzed was characterized by a deficit in March, April, May and August and an excess of +51.2 mm in July, during the period of fruit ripening, which can leads to the phenomenon of fruit cracking (Engin *et al*, 2009).

In sweet cherry, the absence of rain and high day and night temperatures produced variations in flowering, productivity and fruit quality from year to year. Changes in the rainfall distribution pattern led to the manifestation of water stress with direct effects on the species phenological development specific (Jităreanu *et al*, 2009; Bhattacharjee *et al*, 2022).

Table 1

Climate conditions during the experimental period (RSFG Iași-Romania, 2023)

Period	Air temperature (℃)			Precipitation (mm)			Relative humidity (%)
	Average	Multiannual	Deviation	Sum	Multiannual	Deviation	Average
March	6.60	3.10	+3.50	5.80	28.90	-23.10	58.00
April	9.70	10.30	-0.60	2.00	28.90	-26.90	66.00
May	16.20	16.10	+0.10	5.00	27.40	-22.40	54.00
June	20.70	19.40	+1.30	10.00	28.10	-18.10	53.00
July	23.30	21.30	+2.00	91.50	40.30	+51.20	51.00
August	25.45	20.50	+4.95	9.20	57.60	-48.40	51.00
Average/sum	**16.99**	**15.12**	**+ 1.88**	**123.50**	**211.20**	**- 87.70**	**55.50**

The rate of dehydration in the flowering phenophase oscillated both between cultivars and between the two areas of the crown analyzed.

The lowest rate of dehydration was recorded in the 'Van' cultivar (33.14% in the internal area of the crown and 37.70% external) (*figure 1*). Analyzing the obtained data, it is highlighted that in the external area of the crown, the rate of dehydration was more pronounced at all cultivars.

Statistically significant differences were recorded between the analyzed experimental variants.

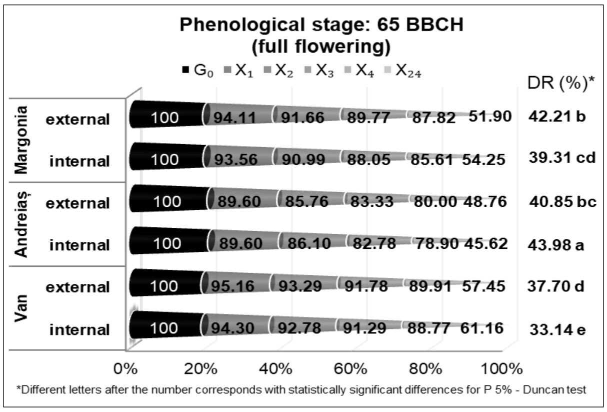

Figure 1 **The rate of dehydration in the phenophase of full flowering (RSFG Iași-Romania, 2023)**

In the phenophase of fruit growth, the obtained results of the dehydration rate were on average lower compared to the phenophase of flowering, highlighting a slowing down of the dehydration process, except for the 'Van' cultivar.

During this phenological stage, the lowest rate of dehydration was obtained on average in the 'Andreiaș' cultivar outside the crown (32.83%) and 'Margonia' in the internal area, with 32.61% (*figure 2*).

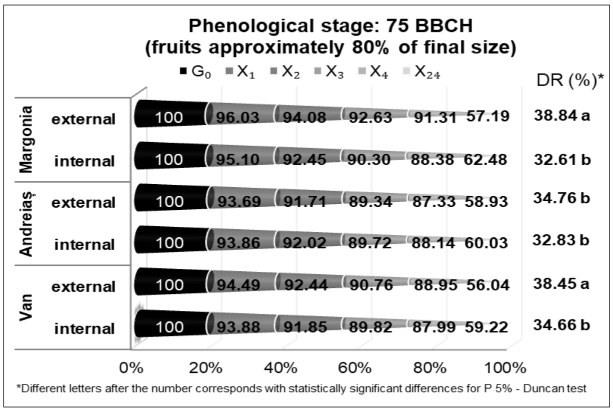

Figure 2 **The rate of dehydration in the phenophase of fruit growth (RSFG Iași-Romania, 2023)**

With regard to the phenophase of fruit ripening, each cultivar evaluated has its own specificity.

The 'Margonia' cultivar maintained its rate of dehydration compared to the phenophase of fruit growth, while a significant decrease was recorded in the 'Van' cultivar (from 34.66 to 23.03% and from 38.45 to 24.02%). The 'Andreiaş' cultivar recorded a decrease in the rate of dehydration inside the crown (to 24.46%), with a significant difference compared to the outside of the crown (32.91%).

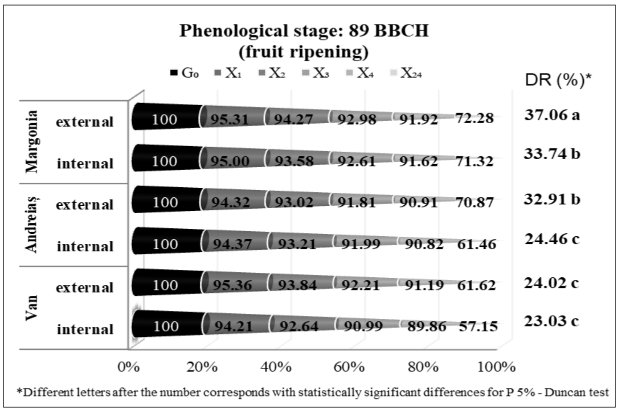

Figure 3 **The rate of dehydration in the phenophase of fruit ripening (RSFG Iași-Romania, 2023)**

Comparing the three phenophases studied, in the flowering phenophase the maximum values of the dehydration rate were obtained between 33.14 and 43.98%, in the fruit growth phenophase, constant values between 38.84 and 32.61% and the lowest dehydration rate was recorded in the phenophase of fruit ripening with values between 23.03 and 37.06 %.

The variability of the evaporation process during the fruit ripening period could also be explained by the excess of precipitation recorded during that period (+ 51.2 mm), after a period of severe drought associated with higher temperatures than the multiannual average.

The assessment of water content and total dry matter was done dynamically during the growing season (*figure 4*). Thus, in the flowering phenophase, average values of the water content of 69.35-70.62% were obtained, with statistically insignificant differences between the analyzed experimental variants. In the phenophase of fruit growth, the water content remained constant at values between 67.83 and 69.81%, although in terms of precipitation, a deficit was recorded during that period.

In the phenophase of fruit ripening, the water content at leaf level decreased significantly, reaching the minimum value from 61.56% at the 'Andreiaș' cultivar in the external part of the crown.

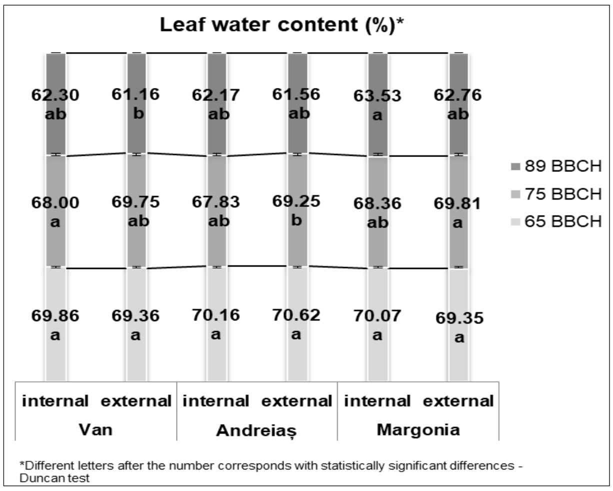

Figure 4 **The leaf water content during the phenophases (RSFG Iași-Romania, 2023)**

Correlated with the climatic conditions, it was highlighted that the transport of assimilates to the fruits was not negatively influenced by the high temperatures and the sudden excess of precipitation during this phenophase, the final production not being affected. In all analyzed phenophases, no very significant statistical differences were recorded between cultivars.

In this case, the levels of water use efficiency differed more from one cultivar to another, but also from the crown area, depending also on the phenophase, due to the variability of climatic factors in these periods.

CONCLUSIONS

The analysis of the evolution of climatic conditions during the vegetation period (March-August) of 2023 showed that the studied sweet cherry cultivars can be characterized by a high capacity to absorb and maintain water in conditions of low water availability, although there were conditions of thermal and water stress.

The water content of the leaves of the shoots generally has relatively close values in all the cultivars studied, confirming the traits of the species.

The rate of dehydration varied even within the same cultivar in different areas of the crown. The evaporation process was lower inside the crown.

The most intense rate of dehydration and water content at the foliar level was recorded in the 'Andreiaș' cultivar, in the flowering phenophase.

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